

What is Claimed:

- 1                   1.     A system for positioning a die on a substrate, the system  
2     comprising:  
3                    an alignment tool having a plurality of internal reflection surfaces, the  
4     alignment tool located below a vision plane of the substrate; and  
5                    an optical detector to receive an indirect image of a bottom surface of  
6     the die through the alignment tool,  
7                    wherein the die is positioned on the substrate based on the indirect image  
8     received by the optical detector for correct alignment of the die on the substrate.
- 1                   2.     The system according to claim 1, wherein optical detector is  
2     positioned above a top surface of the offset alignment tool.
- 1                   3.     The system according to claim 1, wherein the alignment tool  
2     comprises a plurality of cornercube offset tools, each one having a respective plurality  
3     of internal reflection surfaces.
- 1                   4.     The system according to claim 1, wherein the alignment tool is  
2     formed from one of fused silica, sapphire, diamond, calcium fluoride and an optical  
3     glass.
- 1                   5.     The system according to claim 1, wherein a vertex of the  
2     cornercube offset tool is located at a position about midway between an optical axis of  
3     the optical detector and an optical axis of the die.
- 1                   6.     The system according to claim 1, further comprising a die  
2     placement tool,  
3                    wherein the alignment of the die on the substrate is based on a positional  
4     offset of the die placement tool from a reference position.
- 1                   7.     A system for positioning a die on a substrate, the system  
2     comprising:

3                   a plurality of cornercube offset tools each having a respective plurality  
4 of internal reflection surfaces, the plurality of cornercube offset tools located below a  
5 vision plane of the substrate; and

6                   an optical detector to receive an indirect image of a bottom surface of  
7 the die through at least one of the plurality of cornercube offset tools,

8                   wherein the die is positioned on the substrate based on the indirect image  
9 received by the optical detector.

1                   8.     The system according to claim 7, wherein a camera receives the  
2 indirect image of the bottom surface of the die through the cornercube offset tool.

1                   9.     The system according to claim 7, wherein a vertex of the  
2 cornercube offset tool is located at a position about midway between an optical axis of  
3 the optical detector and an optical axis of the die.

1                   10.    The system according to claim 9, wherein a focal plane of the  
2 system is positioned above the vertex of the cornercube offset tool.

1                   11.    The system according to claim 7, further comprising:  
2                   a respective plurality of first lenses disposed between the optical input  
3 means and each of the plurality of cornercube offset tools; and  
4                   a respective plurality second lenses disposed between the die and each of  
5 the plurality of cornercube offset tools.

1                   12.    The system according to claim 11, wherein the plurality of first  
2 lenses and the plurality of second lenses are located below the image plane.

1                   13.    The system according to claim 11, wherein the plurality of first  
2 lenses and the plurality of second lenses each have a unitary magnification factor.

1                   14.    The system according to claim 7, wherein each of the plurality of  
2 cornercube offset tools are formed from one of fused silica, sapphire, diamond,  
3 calcium fluoride and an optical glass.

- 1                   15.    The system according to claim 7, wherein each of the plurality of  
2   the cornercube offset tools has an apex angle of about 90°, a second angle of about  
3   45° and a third angle of about 45°
- 1                   16.    The system according to claim 7, wherein optical detector is a  
2   camera.
- 1                   17.    The system according to claim 16, wherein the camera is a CCD  
2   camera.
- 1                   18.    The system according to claim 7, wherein the optical detector is a  
2   CMOS imager.
- 1                   19.    The system according to claim 7, wherein the cornercube offset  
2   tool has an index of refraction between about 1.5 and 1.7.
- 1                   20.    The system according to claim 7, wherein the cornercube offset  
2   tool has an index of refraction of about 1.517.
- 1                   21.    The system according to claim 7, wherein the system is used with  
2   light having a wavelength in the visible spectrum.
- 1                   22.    The system according to claim 7, wherein the system is used with  
2   light having a wavelength between about 1-3000nm.
- 3                   23.    The system according to claim 7, wherein the system is used with  
4   light having a wavelength between about 630-690 nm.
- 1                   24.    The system according to claim 7, wherein the system is used with  
2   light having a wavelength between about 1-400 nm.
- 1                   25.    The system according to claim 7, wherein the system is used with  
2   light having a wavelength between about 700-3000 nm.

1                   26.    The system according to claim 7, wherein the system is used with  
2 light having a wavelength of about 660 nm.

1                   27.    The system according to claim 7, further comprising:  
2                   a lens positioned in both i) a first optical axis between the optical input  
3 means and respective ones of the plurality of cornercube offset tools and ii) a second  
4 optical axis between the die and the cornercube offset tool, wherein the first and  
5 second optical axis are substantially parallel to one another.

1                   28.    A vision system for use with an optical detector for positioning a  
2 die on a substrate, the system comprising:

3                   a plurality of cornercube offset tools each having a plurality of internal  
4 reflection surfaces, the plurality of cornercube offset tools located below a vision  
5 plane of the die;

6                   a lens positioned in both i) a first optical axis between the vision plane  
7 and each of the plurality of cornercube offset tools and ii) a second optical axis  
8 between the optical detector and the plurality of cornercube offset tools,

9                   wherein the optical detector receives an indirect image of a bottom  
10 surface of the die through at least one of the plurality of cornercube offset tools.

1                   29.    The cornercube offset tool according to claim 28, wherein the  
2 plurality of internal reflection surfaces are three internal reflection surfaces.

1                   30.    A vision system according to claim 28, wherein the optical  
2 detector is positioned above the image plane.

1                   31.    A vision system according to claim 28, wherein the first optical  
2 axis and the second optical axis are substantially parallel to one another.

1                   32.    The device according to claim 28, wherein the lens has a unitary  
2 magnification factor.

1                   33.    The device according to claim 28, wherein the lens is a respective  
2   plurality of first lenses positioned in the first optical axis and a respective plurality of  
3   second lenses positioned in the second optical axis.

1                   34.    The device according to claim 33, wherein the plurality of first  
2   lenses and the plurality of second lenses each have a unitary magnification factor.

1                   35.    A vision system for use with a bonding machine for placing a die  
2   on a substrate, the system comprising:

3                         a cornercube offset tool having three internal reflection surfaces, the  
4   cornercube offset tool located below a vision plane of the bonding machine; and

5                         an optical detector to receive an indirect image of the die through the  
6   cornercube offset tool,

7                         wherein the die is placed on the substrate based on the indirect image  
8   received by the optical detector, for correct alignment of the die on the substrate.

1                   36.    A vision system according to claim 35, wherein at least one of the  
2   internal reflection surfaces is a total internal reflection surface.

1                   37.    A vision system according to claim 35, wherein the plurality of  
2   internal reflection surfaces are total internal reflection surfaces.

1                   38.    A vision system according to claim 35, further comprising a die  
2   placement tool,

3                         wherein the alignment of the die on the substrate is based on a positional  
4   offset of the die placement tool from a reference position.

1                   39.    A system for positioning a die on a substrate, the system  
2   comprising:

3                         image redirecting means disposed below a vision plane of the substrate,  
4   the image redirecting means having a plurality of internal reflection surfaces; and

5                   detecting means to receive an indirect image of a bottom surface of the  
6 die through the image redirecting means,

7                   wherein the die is positioned on the substrate based on the indirect image  
8 received by the detecting system, for correct alignment of die on the substrate.

1                   40.    A vision system according to claim 39, further comprising a die  
2 placement means,

3                   wherein the alignment of the die on the substrate is based on a positional  
4 offset of the die placement means from a reference position.

1                   41.    A method for positioning a die on a substrate, the method  
2 comprising the steps of:

3                   providing a cornercube offset tool below a vision plane of the substrate,  
4 the cornercube offset tool having three internal reflection surfaces;

5                   viewing an indirect image of the die through the cornercube offset tool;

6                   identifying a feature located on a bottom surface of the die based on the  
7 indirect image; and

8                   placing the die on the substrate based on the identified feature.

1                   42.    A method for positioning a die on a substrate, the method  
2 comprising the steps of:

3                   positioning a plurality of cornercube offset tools below a vision plane of  
4 the substrate;

5                   positioning a first lens between each of the plurality of cornercube offset  
6 tools and the die;

7                   positioning a second lens between each of the plurality of cornercube  
8 offset tools and an optical input device; and

9                   viewing a surface of the die through the first lens, the cornercube offset  
10 tool, and the second lens.

1                    43.    A method for use with a bonding machine to place a die on a  
2    substrate, the method comprising the steps of:

3                    positioning a cornercube offset tool below a vision plane of the bonding  
4    machine;

5                    positioning a lens between i) the vision plane and the cornercube offset  
6    tool and ii) between an optical input device and the cornercube offset tool;

7                    viewing a portion of a bottom surface of the die through the cornercube  
8    offset tool and the lens; and

9                    placing the die on the substrate based on the viewed portion of the die.